On the Specific Gravity Methods in Grading the Wheat Seeds, as a Control-Means for the Seedling Blight, caused by *Gibberella Saubinetii* (Mont.) Sacc.

By

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Contents.

I. Introduction.

The wheat scab or the wheat blight caused by *Gibberella Saubinetii* (Mont.) Sacc. is chiefly disseminated through the diseased seeds. The fungus disturbs not only the germination of the wheat seeds sown, but also it attacks the germinated seedlings. Therefore the seed wheat to be sown, must be secured only

from not-diseased wheat plants grown in healthy fields. If it occur to rain for a long time in the cropping season of wheat, however, the outbreak of the ear-blight, or head-blight may be very severe, covering a comparatively large area. In southern Kyûsyû of Japan, it rains for very long time in the season almost every year. In such a case, securing of healthy grains from not-blighted fields is very hard.

In the practice of breeding, the highly improved or pure bred wheat varieties are sometimes attacked by the disease, and the long years' laborious efforts may be destroyed. But in such a case the wheat grains formed on the blighted ears are obliged to sow as the seeds for next generation.

It is very useful to determine whether the wheat grains produced on blighted heads may be used as seeds, in what degree they are affected by the disease and to know how they may be protected from the seedling blight. On this point, Bokura[1,2] cited the result of the Hokkaidô Agricultural Experiment Station on the grading of wheat grains, attacked by *Gibberella Saubinetii*, with a winnowing machine, and recommended the selection of the grains by the machine or by the brine soaking.

The writers set up their experiments to grade the wheat grains by the specific gravity or the size, and to select healthy seeds among those formed on blighted heads. The results are given in the present paper, although some of the results were preliminarily reported in Japanese already[3–5].

The present experiment was carried out chiefly on the expence defrayed by the Japanese Department of Agriculture and Forestry, to which the writers are much obliged.

II. Methods of Experiments.

In this place only the following methods are given: (1) to grade wheat grains by specific gravity, (2) to determine the germination percentage of wheat grains and (3) to show the percentage of the presence of internal hyphae in wheat grains are given.

1) *Specific Gravity Method in Grading Wheat Grains.*

Water solutions of magnesium chloride having the specific gravity of 1.00, 1.05, 1.10, 1.15, 1.20 and 1.24 were prepared with commercial bittern. Wheat grains under the test, were first soaked in water. The grains floated on the water were below 1.00 in specific gravity, and they were scooped off and separated. The grains sunken in water, the specific gravity being above 1.00,

1) Bokura, U. Zituyô Nôsakubutu Byôgai Yôsetu. Tokyo, 1934.
2) Bokura, U. Mugi-Rui no Byôgai to sono Bôzyo. Tokyo, 1936.
3) Nisikado, Y. Nôrinsyô-Itaku Komugi no Akakabibyô Bôzyo ni kansuru Kenkyû. Syôwa 9 Nendo Kenkyû-Keikwa Gaiyô, 1935.
4) Nisikado, Y. Ditto. Syôwa 11 Nendo Kenkyû-Keikwa Gaiyô, 1937.
5) Nisikado, Y. and Hirata, K. Komugi no Akakabibyô no Itizi-Hassei Bôsihô to site-no Higai-Ryû no Hizyû-Sen (I–II). Journal of Plant Protection, 25: 27–33; 101–108, 1938.

were then put into the solution of specific gravity 1.05. As stated above, these wheat grains were divided into two classes below and above 1.05 in specific gravity. In this way the wheat grains of all the varieties tested were separated into following seven classes according to their specific gravity: (1) below 1.00, (2) 1.00 - 1.05, (3) 1.05 - 1.10, (4) 1.10 - 1.15, (5) 1.15 - 1.20, (6) 1.20 - 1.24 and (7) above 1.24.

2) *Germination Percentage of Wheat Grains.*

The wheat grains, to be tested, were sown on sand layer in germination tray, keeping the water content of the sand about 50 per cent of the saturation. They were kept at 24°C, and the percentage of the complete germination was studied after 5, 8 and 10 days' incubation, respectively.

3) *Percentage of the Presence of Internal Hyphae in Wheat Grains.*

As the surface of the wheat grains may be contaminated with various microorganisms, surface disinfection was first done. The grains were soaked in 50 per cent alcohol for about 2 minutes and then in 0.1 per cent solution of mercuric chloride for about two minutes. By means of sterilized pincettes, the treated grains were placed on the surface of agar medium in Petri dishes, the grains being separated from each other. The Petri dishes, thus sown, were then kept in an incubator set at 24°C. The development of the colonies of *Gibberella Saubinetii* around the wheat grains was inspected, and the percentage of the presence of internal hyphae in wheat grains was determined.

To ascertain whether the fungus colonies, developed around the wheat grains, was really of *Gibberella Saubinetii*, a preliminary experiment was undertaken. The colonies of *Gibberella Saubinetii* show usually red color on some culture

Table 1.

Coloring of Colonies of *Gibberella Saubinetii* (Mont.) Sacc., grown on Culture Media, containing Various Carbohydrates in Various Concentrations after 5 and 10 days' Incubation at 24°C., respectively.

The standard culture medium, to which various carbohydrates were added, was rice-decoction agar.

Coloring of colonies	After 5 days			After 10 days		
Concentration of carbohydrates	1.0 %	2.0 %	3.0 %	1.0 %	2.0 %	3.0 %
Dextrose	++	++	+++	++++	++++	++++
Saccharose	++	+++	+++	++++	++++	++++
Corn-starch	++++	++++		++++	++++	
Rice-flour	++++	++++		++++	++++	
Wheat-flour	++++	++++		++++	++++	
Potato-starch	+	+		+++	+++	

Remarks: In this table number of plus signs shows the degree of coloring of colonies, and the more the plus signs the deeper the coloring.

media, especially on those containing carbohydrates. Therefore, various carbohydrates were added to the standard rice-decoction agar. For the preparation of this medium, 100 g of rice straw were added to 1,000 cc of tap water and boiled for one hour at 100°C. To the decoction, 2 g of agar were added. To the rice-decoction agar medium, thus prepared, dextrose, sucrose, corn-starch, wheat-flour, rice-flour or potato-starch was added in the rate of 1, 2 and 3 per cent, respectively. After sterilization 15 cc of the medium were poured into a PETRI dish. To these media, a 2 mm circular bit of agar culture of *Gibberella Saubinetii* was transferred. After 5 and 10 days culture at 24°C, the coloring of the fungus colonies on various culture media was inspected and the results are shown in Table 1.

(See Table 1 on 127 page.)

Table 1 shows that the coloring of the colonies after 5 days culture differred with the culture media used. The coloring of the colonies on the media containing rice-flour or wheat-flour was deeper than that on the other media. After 10 days, however, the difference in the degree of the coloring of colonies decreased greatly. The agar media containing rice-flour and wheat-flour were not translucent and difficult to observe the fungus colonies from the bottom of PETRI

Table 2.

Results of Experiments regarding the Specific Gravity of Wheat Grains, attacked by the Head-Blight Fungus, *Gibberella Saubinetii* (Mont.) Sacc.

Specific gravity			Germination percentage				Internal infection of *Gibberella Saubinetii*		
Class	No. of grains found	Per-centage	No. of grains studied	After 6 days	After 8 days	After 10 days	No. of grains studied	No. of grains infected	Per-centage
Wheat variety: Nôrin No. 5.									
Below 1.00	358	14.28	100	2.0	3.0		30	5	16.7
1.00 – 1.05	46	1.85	16	0	0		30	4	13.3
1.05 – 1.10	142	6.06	100	3.0	0		30	4	13.3
1.10 – 1.15	169	6.74	100	20.0	24.0		30	3	10.0
1.15 – 1.20	192	7.66	100	38.0	43.0		30	2	6.7
1.20 – 1.24	322	12.84	100	71.0	77.0		30	0	0
Above 1.24	1278	51.34	100	95.8	97.5		30	0	0
Wheat variety: Kinai No. 9.									
Below 1.00	82	3.87	67	10.5	18.0	19.4	15	5	33.3
1.00 – 1.05	8	0.38	0				8	1	1.25
1.05 – 1.10	32	1.51	20	15.0	20.0	20.0	12	0	0
1.10 – 1.15	48	2.27	33	3.0	3.0	3.0	12	0	0
1.15 – 1.20	69	3.26	52	13.4	13.4	13.4	12	0	0
1.20 – 1.24	69	3.26	56	30.4	39.3	39.3	12	0	0
Above 1.24	1811	85.46	100	96.0	97.0	97.0	12	0	0

dishes. Meanwhile rice-decoction agar containing 3 per cent sucrose or dextrose was comparatively translucent and suitable for the observation of colonies. Therefore the rice-decoction agar with 3 per cent sucrose was used throughout the experiment.

III. Grading of Wheat Grains, produced on Blighted Heads, by Specific Gravity Method.

By the above stated methods, experiments were carried out with the wheat grains of twelve varieties, which were harvested in the summer, 1937, from artificially inoculated and heavily blighted ears. The grains were first graded by the specific gravity into seven classes and the percentage of the grains in each class was calculated. Then the percentage of the germination of the wheat grains in each class of specific gravity, after 6, 8 and 10 days' incubation at 24°C was studied. The percentage of the existence of the internal hyphae in the wheat grains was also studied. The results are shown in Table 2.

Table 2. (Continued.)

Specific gravity			Germination percentage				Internal infection of *Gibberella Saubinetii*		
Class	No. of grains found	Percentage	No. of grains studied	After 6 days	After 8 days	After 10 days	No. of grains studied	No. of grains infected	Percentage
Wheat variety: Kinai No. 114.									
Below 1.00	159	9.66	100	8.0	11.0	11.0	30	2	6.7
1.00 – 1.05	35	2.13	0				30	3	10.0
1.05 – 1.10	89	5.48	31	16.1	25.8	25.8	30	3	10.0
1.10 – 1.15	97	5.88	54	14.8	25.9	25.9	30	2	6.7
1.15 – 1.20	123	7.47	86	22.1	26.7	26.7	30	1	3.3
1.20 – 1.24	139	8.44	100	52.0	54.0	55.0	30	1	3.3
Above 1.24	1004	60.98	100	80.0	82.0	82.0	30	0	0
Wheat variety: Kônosu No. 25.									
Below 1.00	380	18.25	100	8.0	11.0	11.0	30	4	13.3
1.00 – 1.05	90	4.32	70	17.0	19.0	19.0	19	2	10.5
1.05 – 1.10	138	6.63	100	19.0	20.0	20.0	30	2	6.7
1.10 – 1.15	132	6.34	100	28.0	28.0	28.0	27	0	0
1.15 – 1.20	149	7.16	100	53.0	53.0	54.0	30	0	0
1.20 – 1.24	187	8.98	100	73.0	73.0	73.0	30	0	0
Above 1.24	1006	48.32	100	96.0	96.0	96.0	30	0	0

Table 2. (Continued.)

Specific gravity			Germination percentage				Internal infection of *Gibberella Saubinetii*		
Class	No. of grains found	Per-centage	No. of grains studied	After 6 days	After 8 days	After 10 days	No. of grains studied	No. of grains infected	Per-centage
Wheat variety: Nitta-Wase.									
Below 1.00	275	19.57	83	12.1			30	7	23.3
1.00 – 1.05	43	3.06	18	11.1			20	3	15.0
1.05 – 1.10	41	2.97	21	9.5			20	2	10.0
1.10 – 1.15	48	3.32	20	20.0			20	2	10.0
1.15 – 1.20	86	6.12	51	47.1			30	1	3.3
1.20 – 1.24	97	6.90	67	52.2			30	0	0
Above 1.24	815	57.99	96	94.6			30	0	0
Wheat variety: Aiti-Akatake No. 1.									
Below 1.00	408	23.40	100	9.2	21.5	21.5	30	4	13.3
1.00 – 1.05	67	3.92	28	7.1	35.7	39.3	30	2	6.7
1.05 – 1.10	72	4.23	35	11.4	22.9	28.6	30	3	10.0
1.10 – 1.15	93	5.44	54	22.4	40.7	46.3	30	3	10.0
1.15 – 1.20	126	7.37	94	30.8	44.7	46.8	30	5	16.7
1.20 – 1.24	140	8.20	100	61.0	64.0	64.0	30	0	0
Above 1.24	803	47.00	100	90.0	92.0	92.0	30	0	0
Wheat variety: Nakate-Aka.									
Below 1.00	210	9.30	150	14.0	15.3		30	10	23.3
1.00 – 1.05	81	3.68	60	25.0	30.0		30	4	13.3
1.05 – 1.10	100	4.43	75	9.3	9.3		30	2	6.7
1.10 – 1.15	126	5.58	95	18.9	20.0		30	1	3.3
1.15 – 1.20	157	6.91	110	20.0	21.7		30	1	3.3
1.20 – 1.24	200	8.86	130	55.4	57.7		30	0	0
Above 1.24	1383	61.28	150	95.3	96.7		30	0	0
Wheat variety: Hatakeda.									
Below 1.00	991	18.36	100	23.0	26.0	26.0	30	14	46.7
1.00 – 1.05	209	3.88	50	34.0	38.0	39.0	30	4	13.3
1.05 – 1.10	179	3.32	100	39.0	39.0	40.0	30	6	20.0
1.10 – 1.15	236	4.38	100	51.0	59.0	59.0	30	1	3.3
1.15 – 1.20	403	7.48	100	75.0	79.0	80.0	30	1	3.3
1.20 – 1.24	425	7.89	100	87.0	94.0	95.0	30	0	0
Above 1.24	2943	54.64	100	98.0	100.0	100.0	30	1	3.3

Table 2. (Continued.)

Specific gravity			Germination percentage				Internal infection of *Gibberella Saubinetii*		
Class	No. of grains found	Per-centage	No. of grains studied	After 6 days	After 8 days	After 10 days	No. of grains studied	No. of grains infected	Per-centage
Wheat variety: Nakate-Sôsyû No. 6.									
Below 1.00	430	16.17	94	11.7	1.49	14.9	30	6	20.0
1.00 – 1.05	65	1.99	28	32.1	35.7	42.9	30	1	3.3
1.05 – 1.10	58	1.78	25	52.0	52.0	52.0	30	1	3.3
1.10 – 1.15	119	3.26	81	61.7	63.0	66.6	30	1	3.3
1.15 – 1.20	252	7.72	99	77.7	80.8	80.8	30	0	0
1.20 – 1.24	421	12.90	100	74.0	76.0	77.0	30	0	0
Above 1.24	1917	58.65	100	83.0	85.0	86.0	30	0	0
Wheat variety: Kumamoto-Komugi.									
Below 1.00	574	22.63	95	8.4	8.4	10.5	30	7	23.3
1.00 – 1.05	126	4.97	90	11.1	12.2	13.3	30	4	13.3
1.05 – 1.10	202	7.97	100	21.0	23.0	24.0	30	4	13.3
1.10 – 1.15	217	8.56	100	48.0	49.0	49.0	30	5	16.7
1.15 – 1.20	331	13.05	100	56.0	58.0	59.0	30	0	0
1.20 – 1.24	212	8.36	100	74.0	76.0	77.0	30	1	3.3
Above 1.24	874	34.46	100	83.0	85.0	86.0	30	0	0
Wheat variety: Pusa No. 12.									
Below 1.00	374	19.75	100	5.0	6.0	9.0	32	15	46.6
1.00 – 1.05	89	4.54	60	10.0	10.0	11.7	20	10	50.0
1.05 – 1.10	121	6.39	100	13.0	15.0	15.0	30	6	20.0
1.10 – 1.15	116	6.12	100	12.0	15.0	15.0	16	4	25.0
1.15 – 1.20	170	8.98	100	10.0	12.0	14.0	32	6	18.8
1.20 – 1.24	166	8.76	100	22.0	22.0	23.0	32	4	12.5
Above 1.24	861	45.47	100	74.0	75.0	75.0	32	1	3.1
Wheat variety: Minami-Kyûsyû No. 1.									
Below 1.00	240	9.57	100	9.0	13.0	19.0	31	22	70.9
1.00 – 1.05	77	3.07	50	14.0	14.0	14.0	26	18	69.2
1.05 – 1.10	76	3.03	50	8.0	10.0	12.0	26	12	46.2
1.10 – 1.15	92	3.67	70	24.3	24.3	24.3	22	14	63.6
1.15 – 1.20	178	7.10	100	20.0	27.0	27.0	31	11	35.5
1.20 – 1.24	215	8.57	100	61.0	62.0	64.0	31	10	32.3
Above 1.24	1630	64.99	100	96.0	96.0	96.0	31	0	0

1. Specific Gravity of Wheat Grains, produced on Blighted Heads.

From the figures shown in Table 2, the percentage of wheat grains found in each of the seven classes of the specific gravity were summarized in Table 3.

Table 3.

Specific Gravity of Wheat-Grains, produced on Blighted Heads, caused by *Gibberella Saubinetii* (Mont.) Sacc.

Variety \ Specific gravity	Below 1.00	1.00 – 1.05	1.05 – 1.10	1.10 – 1.15	1.15 – 1.20	1.20 – 1.24	Above 1.24
1. Nôrin No. 5	14.3	1.9	6.1	6.7	7.7	12.8	51.3
2. Kinai No. 9	3.9	0.4	1.5	2.3	3.3	3.3	85.5
3. Kinai No. 114	9.7	2.1	5.5	5.9	7.5	8.4	61.0
4. Kônosu No. 25	18.3	4.3	6.6	6.3	7.2	9.0	48.3
5. Nitta-Wase	19.6	3.1	3.0	3.3	6.1	6.9	58.0
6. Aiti-Akatake No. 1	23.4	3.9	4.2	5.4	7.4	8.2	47.0
7. Nakate-Aka	9.3	3.7	4.4	5.6	6.9	8.9	61.3
8. Hatakeda	18.4	3.9	3.3	4.4	7.5	7.9	54.6
9. Nakate-Sôsyû No. 6	13.2	2.0	1.8	3.3	7.7	12.9	58.7
10. Kumamoto-Komugi	22.6	5.0	8.0	8.6	13.1	8.4	34.5
11. Pusa No. 12	19.8	4.5	6.4	6.1	9.0	8.8	45.5
12. Minami-Kyûsyû No. 1	9.6	3.1	3.0	3.7	7.1	8.6	65.0
Average	20.7	3.7	4.9	5.6	8.0	8.8	48.4

According to Table 3, almost all the varieties tested showed that the percentage of the wheat grains of above 1.24 in specific gravity were very large comparing with the other classes of the specific gravity. It might be naturally expected that the severer the infection, the less the wheat grains of large specific gravity.

The wheat variety having the largest specific gravity in this experiment was Kinai No. 9, the percentage of the grains more than 1.24 in specific gravity being 85.5 per cent. The percentage of the grains of the class above 1.24 in specific gravity was above 60 per cent in the varieties Minami-Kyûsyû No. 1, Nakate-Aka, Kinai No. 114. It was above 50 per cent in the varieties Nakate-Sôsyû No. 6, Nôrin No. 5, Nitta-Wase and Hatakeda; above 40 per cent in the varieties Kônosu No. 25, Aiti-Akatake No. 1 and Pusa No. 12; and above 30 per cent in the variety Kumamoto-Komugi.

In average of twelve varieties tested, the wheat grains lighter than 1.00 in specific gravity were only 20 per cent, while the grains heavier than 1.24 were 48 per cent, about one half of the total number of the grains tested. The percentage were shown in the number of grains, but they might be of larger percentage if they were calculated in the weight or the volume.

Wheat grains developed on blighted heads of two varieties, Nôrin No. 5 and Hatakeda are shown in Plate IX. In this plate, the following four classes of the grains are given: below 1.00, 1.05–1.10, 1.15–120 and above 1.24 in specific gravity. The wheat grains with the specific gravity less than 1.00 were very thin, shrivelled and had puckered coats, while those of above 1.24 were well-ripened, plump and rotundly in shape.

2. Relations between the Specific Gravity of the Wheat Grains and the Germination Percentage.

The germination tests were carried out with each of seven classes in the specific gravity, after 6, 8 and 10 days' incubation at 24°C, respectively. The germination percentage of the complete germination is shown in Table 4.

Table 4.

Relations between the Specific Gravity and the Germination Percentage in Wheat-Grains, formed on the Heads attacked by *Gibberella Saubinetii* (Mont.) Sacc.

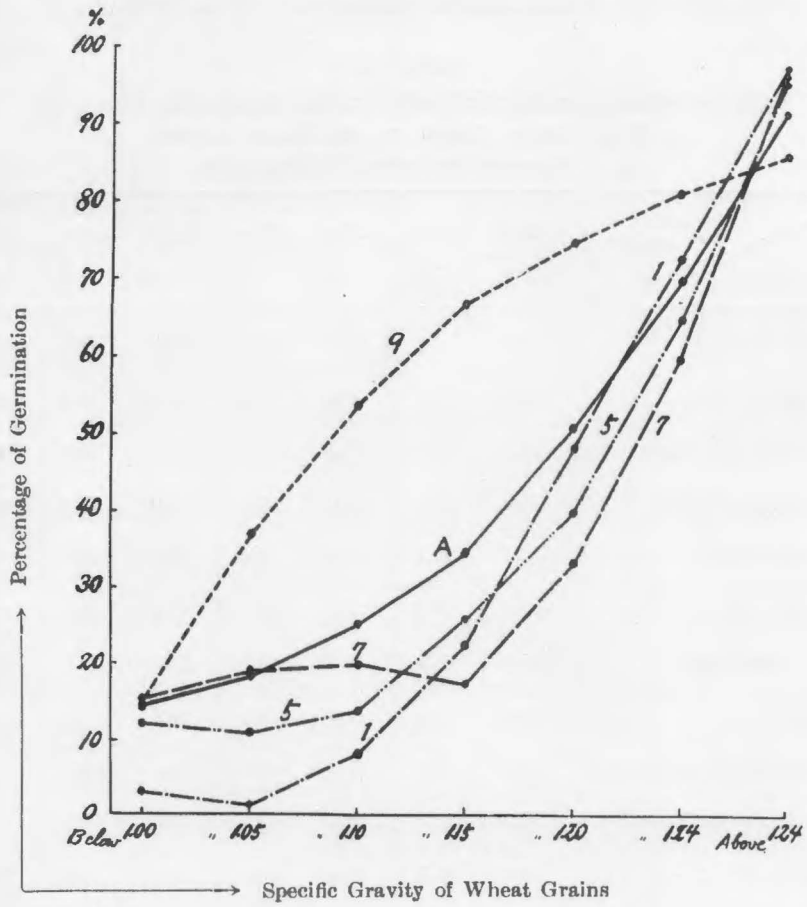
Specific gravity / Variety	Below 1.00	1.00–1.05	1.05–1.10	1.10–1.15	1.15–1.20	1.20–1.24	Above 1.24
1. Nôrin No. 5	3.0	0	0	24.0	43.0	77.0	97.5
2. Kinai No. 9	19.4	—	20.0	3.0	13.4	39.3	97.0
3. Kinai No. 114	11.0	—	25.8	25.9	26.7	55.0	82.0
4. Kônosu No. 25	11,0	19.0	20.0	29.0	57.0	73.0	96.0
5. Nitta-Wase	12.1	11.1	9.5	20.0	47.1	52.2	94.6
6. Aiti-Akatake No. 1	21.5	39.3	28.6	46.3	46.8	64.0	92.0
7. Nakate-Aka	15.3	30.0	9.3	20.0	21.7	57.7	96.7
8. Hatakeda	26.0	39.0	40.0	59.0	80.0	95.0	100.0
9. Nakate-Sôsyu No. 6	14.9	42.9	52.0	66.6	80.8	77.0	86.0
10. Kumamoto-Komugi	10.5	13.3	24.0	49.0	59.0	77.0	86.0
11. Pusa No. 12	9.0	11.7	15.0	15.0	14.0	23.0	75.0
12. Minami-Kyûsyû No. 1	19.0	14.0	12.0	24.3	27.0	64.0	96.0
Average	14.4	18.4	21.4	34.8	46.4	70.4	91.6

The results given in Table 4 are shown in Fig. 1–2 graphically.

The figures given in Table 4 and Fig. 1 and 2 show that the grains heavier than 1.24 in specific gravity were very good in the germination percentage. These wheat grains of six out of twelve varieties showed the germination percentage above 95 per cent, nine varieties above 90 per cent, eleven varieties above 80 per cent and one variety, Pusa No. 12, 75 per cent. The wheat grains between 1.20 and 1.24 in specific gravity showed also pretty good percentage in germination,

Fig. 1.

Graph Showing the Relations between the Specific Gravity and the Germination Percentage in the Wheat Grains, formed on the Heads attacked by *Gibberella Saubinetil* (Mont.) Sacc.

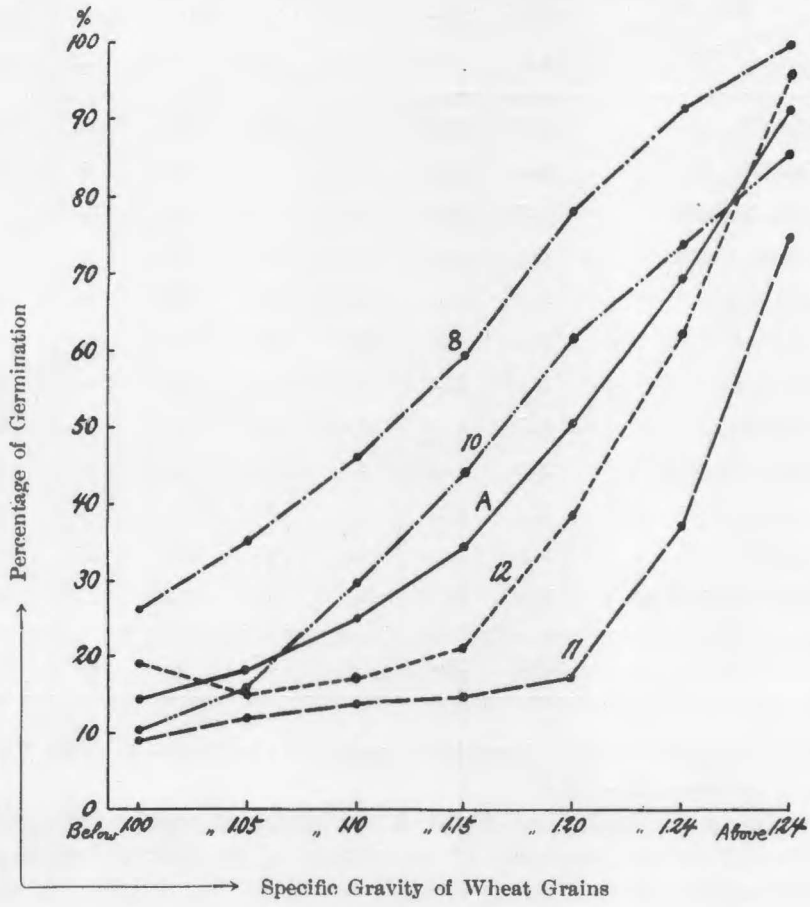


Remarks: In this figure, the curve 1 shows the germination percentage of the wheat grains of the variety Nôrin No. 5; the curve 5, Nitta-Wase; the curve 7, Nakate-Aka; the curve 9, Nakate-Sôsyû and the curve A, the average value of twelve varieties tested.

except the variety Pusa No. 12. The average percentage of the whole varieties tested was 70.4 per cent. In the wheat grains lighter than 1.20 in specific gravity, the germination percentage became less with the decrease of the specific gravity. The germination percentage in the grains of 1.15–1.20 was 46.4 per cent; that of 1.10–1.15, 34.8 per cent; that of 1.05–1.10, 21.4 per cent; that of 1.00–1.05, 18.4 per cent and that of below 1.00 only 14.4 per cent.

Fig. 2.

Graph Showing the Relations between the Specific Gravity and the Germination Percentage in the Wheat Grains, formed on the Heads attacked by *Gibberella Saubinetii* (Mont.) Sacc.



Remarks: In this figure, the curve 8 shows the germination percentage of the wheat grains of the variety Hatakeda; the curve 10, Kumamoto-Komugi; the curve 11, Pusa No. 12; the curve 12, Minami-Kyûsyû No. 1 and the curve A, the average of twelve varieties tested.

3. Relations between the Specific Gravity of the Wheat Grains and the Percentage of the Internal Hyphae of *Gibberella Saubinetii*.

The percentage of the presence of the internal hyphae of *Gibberella Saubinetii* was studied with each of seven classes in specific gravity. The results of twelve varieties are shown in Table 2 and summarized in Table 5.

Table 5.

Relations between the Specific Gravity and the Internal Infection in Wheat Grains, formed on the Heads, attacked by *Gibberella Saubinetii* (Mont.) Sacc.

Specific gravity / Variety	Below 1.00	1.00 – 1.05	1.05 – 1.10	1.10 – 1.15	1.15 – 1.20	1.20 – 1.24	Above 1.24
1. Nôrin No. 5	16.7	13.3	13.3	10.0	6.7	0	0
2. Kinai No. 9	33.3	12.5	0	0	0	0	0
3. Kinai No. 114	6.7	10.0	10.0	6.7	3.3	3.3	0
4. Kônosu No. 25	13.3	10.5	6.7	0	0	0	0
5. Nitta-Wase	23.3	15.0	10.0	10.0	3.3	0	0
6. Aiti-Akatake No. 1	13.3	6.7	10.0	1.00	16.7	0	0
7. Nakate-Aka	33.3	13.3	6.7	3.3	3.3	0	0
8. Hatakeda	46.7	13.3	20.0	3.3	3.3	0	3.3
9. Nakate-Sôsyû No. 6	20.0	3.3	3.3	3.3	0	0	0
10. Kumamoto-Komugi	23.3	13.3	13.3	16.7	0	3.3	0
11. Pusa No. 12	46.6	50.0	20.0	25.0	18.8	12.5	3.1
12. Minami-Kyûsyû No. 1	70.9	69.2	46.2	63.6	35.5	32.3	0
Average	29.0	20.2	13.0	12.7	7.6	4.3	0.5

The results given in Table 5 are shown graphically in Fig. 3 – 4. (See Fig. 3 and Fig. 4 on page 137 – 138.)

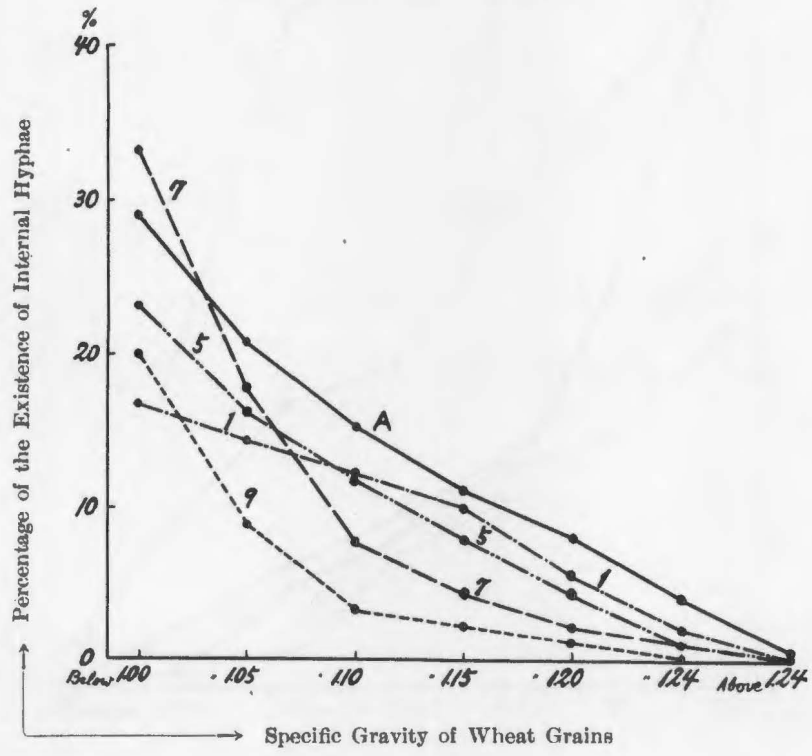
According to Tables 2, 5 and Fig. 3 – 4, the light grains with small specific gravity showed that the percentage of the existence of the internal hyphae was larger, although the relations were somewhat varied with the varieties. In average of twelve varieties, the wheat grains of the specific gravity below 1.00 showed 29.1 per cent in the existence of internal hyphae; those of 1.00 – 1.05, 20.2 per cent; those of 1.05 – 1.10, 13.0 per cent; those of 1.10 – 1.15, 12.7 per cent; those of 1.15 – 1.20, 7.6 per cent; those of 1.20 – 1.24, 4.3 per cent and those of above 1.24, 0.4 per cent. In the heaviest grains more than 1.24 in specific gravity, the ex-

istence of the internal hyphae was proved only in two varieties Hatakeda (3.3 %) and Pusa No. 12 (3.1 %) among 12 varieties tested. It might be supposed that the internal hyphae in these grains were detected accidentally. Even in the grains of 1.20–1.24 in specific gravity, the internal hyphae were found only in four varieties, and the percentage was very small except Minami-Kyûsyû No. 1 (32.3 %) and Pusa No. 12 (12.5 %).

In the majority of the varieties tested, the heavy grains with the specific gravity more than 1.20 showed very small percentage of the existence of the internal hyphae and their germination was very good. In the grains more than 1.24 in specific gravity, the relations were much better. Therefore these wheat grains may be sown as the seeds for the next generation, with adequate precautions.

Fig. 3.

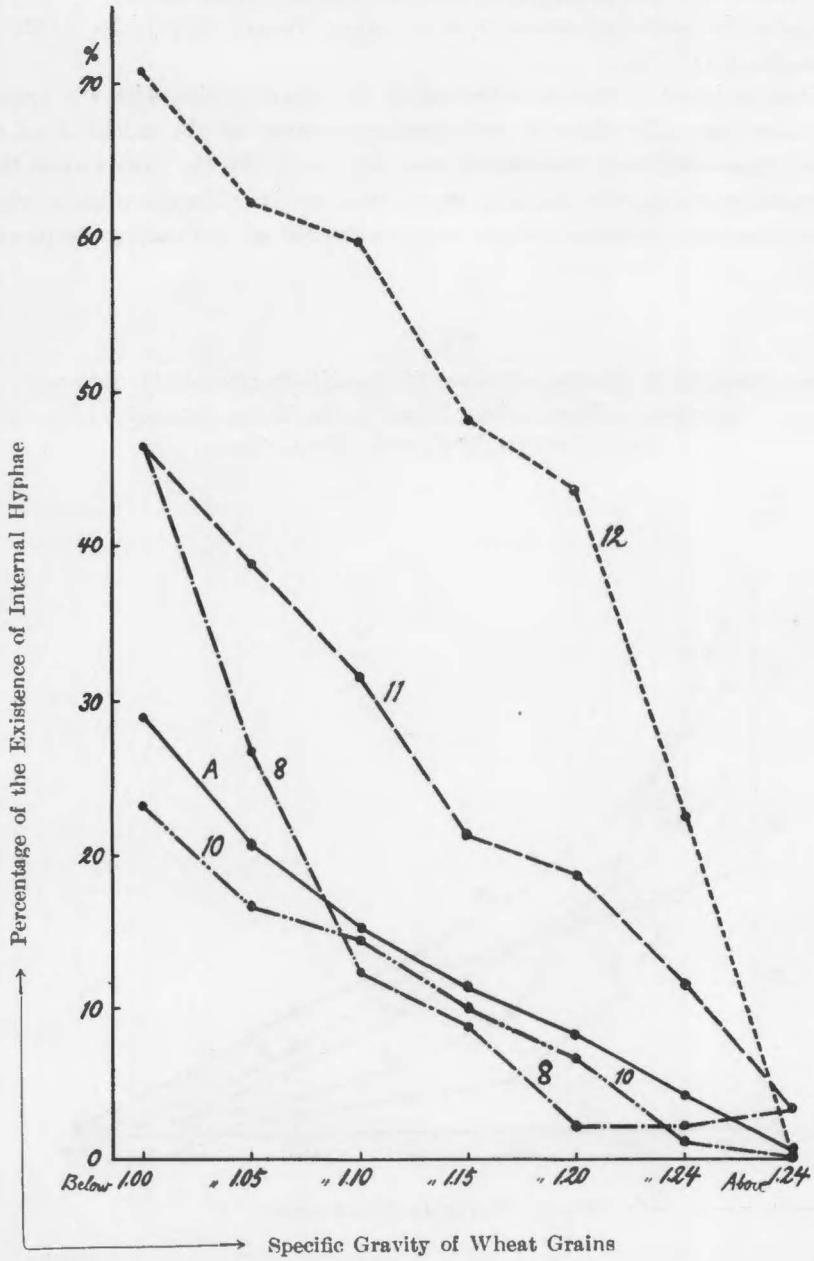
Gragh Showing the Relations between the Specific Gravity and the Internal Infection, in Wheat Grains, formed on the Heads attacked by *Gibberella Saubinetii* (Mont.) Sacc.



Remarks: In this figure, the curve 1 shows the percentage of existence of the internal hyphae in the grains of the wheat variety Nôrin No. 5; the curve 5, Nitta-Wase; the curve 7, Nakate-Aka; the curve 9, Nakate-Sôsyû No. 6 and the curve A, the average value of twelve varieties tested.

Fig. 4.

Graph Showing the Relations between the Specific Gravity and the Internal Infection, in Wheat Grains, formed on the Heads attacked by *Gibberella Saubinetii* (Mont.) Sacc.



Remarks: In this figure, the curve 8 shows the wheat variety Hatakeda; the curve 10, Kumamoto-Komugi; the curve 11, Pusa No. 12; the curve 12, Minami-Kyûsyû No. 1 and the curve A, the average of twelve varieties tested.

IV. Relations among the Shape, the Size and the Specific Gravity of the Wheat Grains produced on Blighted Heads.

1. Results of Experiments in 1934.

i) *Size of Wheat Grains, produced on Blighted Heads.*

The wheat grains, tested in this experiment, were of the variety Hatakeda, which were harvested in 1934 from blighted heads caused by artificial inoculations. The diseased as well as the healthy grains were separated into four classes with the following three kinds of sieves: 20 mm, 25 mm and 27 mm in mesh. The results are given in the following table:

Table 6.

The Diameter of Wheat Grains, formed on Healthy and Blighted Heads.

Class in diameter of grains	Blighted grains		Healthy grains	
	Weight	Percentage	Weight	Percentage
	g.	%	g.	%
Below 20 mm	13.5	21.5	5.2	1.5
20 – 25 „	35.0	55.8	69.7	19.6
25 – 27 „	12.3	19.6	191.3	53.9
Above 27 „	1.9	3.0	88.6	25.0
Total	62.7	100.0	354.8	100.0

The results show that the wheat grains of the variety Hatakeda, formed on the blighted heads were much smaller in diameter than the healthy ones. In the majority, the diseased grains were 20 – 25 mm. in diameter, while the healthy ones, 25 – 27 mm.

ii) *Absolute Weight and Specific Gravity of Wheat Grains, produced on Blighted Heads.*

The results obtained by the experiments on the relations among the size, the absolute weight and the specific gravity of the blighted as well as healthy grains of Hatakeda wheat are given in Table 7.

(See Table 7 on next page.)

The figures given in Table 7 indicate that the weight of a thousand grains of blighted wheat was much smaller than that of healthy ones. This was more significant in the small grains less than 20 mm in diameter. The ratio of the blighted grains to the healthy ones in the class of 20 – 24 mm in diameter, was

0.852 in absolute weight and 0.839 in specific gravity, while that of less than 20 mm was 0.67 in absolute weight and 0.75 in specific gravity, respectively.

Table 7.

The Diameter, the Absolute Weight and the Specific Gravity of Wheat Grains, formed on Healthy and Blighted Heads.

Class in diameter of grains	Weight of a thousand grains			Specific gravity of grains		
	Blighted grains (B)	Healthy grains (H)	Ratio $\frac{B}{H}$	Blighted grains (B)	Healthy grains (H)	Ratio $\frac{B}{H}$
	g.	g.		g.	g.	
Below 20 mm	9.2	13.8	0.667	0.960	1.28	0.750
20 - 25 „	30.1	33.6	0.852	1.090	1.30	0.839
25 - 27 „	28.8	30.1	0.957	1.205	1.31	0.920
Above 27 „	32.9	34.1	0.936	1.285	1.30	0.989

iii) *Ratio of Thickness to Weight of Wheat Grains, produced on Blighted Heads.*

The ratio of thickness to weight of the wheat grains produced on the blighted as well as the healthy heads was studied, the results are given in Table 8.

Table 8.

Comparisons of the Width and the Length of Wheat Grains, formed on Healthy and Blighted Heads.

Class in diameter of grains	Blighted grains			Healthy grains		
	Th < Wd.	Th = Wd.	Th > Wd.	Th < Wd.	Th = Wd.	Th > Wd.
Below 20 mm	6	2	67	49	1	0
20 - 25 „	10	7	58	46	2	0
25 - 27 „	26	11	38	49	1	0
Above 27 „	29	7	14	46	3	1
Total	71	27	177	190	7	3
Percentage (%)	25.8	9.8	64.4	95.0	3.5	1.5

Remarks: In this table, Th = Wd. shows that the thickness of the wheat grains tested was similar to the width; Th > Wd., the thickness was larger than the width and Th < Wd., the thickness was smaller than the width.

The wheat grains with the width larger than the thickness were 95 per cent in the healthy grains and only 25 per cent in the blighted ones. While the grains with the width less than the thickness was 1.5 per cent in the healthy grains and 65 per cent in the blighted grains. In short, the results showed that the blighted grains were much thinner than the healthy ones.

2. Results of Experiments in 1937.

i) *Relations between the Size and the Specific Gravity of Wheat Grains, produced on Blighted Heads.*

Relations between the size and the specific gravity of the grains of the wheat varieties Nôrin No. 4, Nôrin No. 6, Hosogara, Sintyûnaga and Hatakeda, produced in 1937, were studied. According to the size, the wheat grains were separated into four classes of below 2.0, 2.0–2.5, 2.5–2.7 and above 2.7 mm in diameter. The results, as given in Table 9, showed that thin grains less than 2.5 mm in diameter, formed about 90 per cent of the total grains.

Table 9.

Relations between the Size and the Specific Gravity of Wheat Grains, formed on Blighted Heads.

Diameter of wheat grains			Specific gravity of grains (Frequency in percentage)						
Class (mm.)	No. of grains tested	Per-centage	Below 1.00	1.00–1.05	1.05–1.10	1.10–1.15	1.15–1.20	1.20–1.24	Above 1.24
Wheat variety: Nôrin No. 4.									
Below 2.0	1,988	40.4	73.2	3.3	5.7	5.1	5.4	3.8	2.5
2.0–2.5	2,483	50.5	59.0	7.2	4.9	6.6	5.5	4.8	12.0
2.5–2.7	375	7.6	50.1	8.0	5.6	3.2	2.9	4.3	25.9
Above 2.7	71	1.5	38.0	10.3	9.9	2.8	12.7	1.4	23.9
Wheat variety: Nôrin No. 6.									
Below 2.0	1,533	19.6	92.4	1.6	2.2	2.1	0.8	0.4	0.5
2.0–2.5	4,934	63.3	88.1	2.1	2.0	2.0	1.9	1.4	2.5
2.5–2.7	1,073	13.8	80.8	5.9	2.1	1.7	1.8	1.6	6.1
Above 2.7	270	3.4	73.4	7.0	7.0	1.5	2.2	2.6	6.3
Wheat variety: Hosogara.									
Below 2.0	1,762	34.1	65.8	6.5	6.6	7.8	8.2	2.7	2.4
2.0–2.5	2,951	57.3	51.6	5.7	7.3	9.2	8.7	7.2	10.3
2.5–2.7	386	7.5	42.0	9.1	6.2	5.2	7.0	3.4	27.1
Above 2.7	53	1.3	55.9	5.7	5.7	5.7	1.9	3.8	11.3
Wheat variety: Sintyûnaga.									
Below 2.0	2,372	35.1	68.8	6.6	7.9	9.7	4.3	2.0	0.7
2.0–2.5	3,377	50.0	51.1	6.0	7.6	11.6	10.8	7.6	5.3
2.5–2.7	800	11.9	43.1	7.0	7.1	7.6	10.9	10.9	13.4
Above 2.7	201	3.0	48.7	7.5	11.4	8.5	8.9	6.5	8.5
Wheat variety: Hatakeda.									
Below 2.0	2,381	35.2	66.8	4.7	6.8	6.9	7.4	3.9	3.5
2.0–2.5	3,833	56.4	45.3	4.9	5.3	7.5	11.3	11.1	14.6
2.5–2.7	509	7.5	33.8	6.3	5.9	6.3	7.9	10.2	29.6
Above 2.7	63	0.9	54.0	1.6	4.8	9.5	6.3	13.7	11.1

The wheat grains, divided into four classes according to the size, were further graded into seven classes shown below 1.00, 1.00–1.05, 1.05–1.10, 1.10–1.15, 1.15–1.20, 1.20–1.24 and above 1.24 in specific gravity. The results are given in Table 9. The thin grains seemed to be generally small in specific gravity, and those below 2.0 mm in diameter, were mostly of below 1.00 in specific gravity.

ii) *Relations among the Size, the Specific Gravity and the Germination Percentage of Wheat Grains.*

The germination of the wheat grains, as graded above, was studied. The results are given in Table 10.

Table 10.

Relations among the Size, the Specific Gravity and the Germination Percentage of Wheat Grains and the Percentage of the Appearance of *Gibberella Saubinetii* (Mont.) Sacc. during the Germination of the Grains.

Specific gravity	Class in diameter of wheat grains tested (mm)							
	Below 2.0	2.0 – 2.5	2.5 – 2.7	Above 2.7	Below 2.0	2.0 – 2.5	2.5 – 2.7	Above 2.7
	Germination percentage of wheat grains				Percentage of appearance of *G. Saubinetii* during the germination of grains			
Wheat variety: Nôrin No. 4.								
Below 1.00	0	0	0	× 0	80	100	100	100
1.00 – 1.05	7	3	× 0	× 0	50	90	100	100
1.05 – 1.10	7	7	× 0	× 0	43	73	100	100
1.10 – 1.15	13	23	× 8	× 0	20	60	92	100
1.15 – 1.20	7	20	×17	× 0	10	60	67	100
1.20 – 1.24	10	40	×19	× 0	3	20	57	100
Above 1.24	7	7	13	×14	0	7	33	43
Wheat variety: Nôrin No. 6.								
Below 1.00	10	0	0	0	90	100	100	100
1.00 – 1.05	× 33	13	3	× 5	54	87	90	95
1.05 – 1.10	× 63	27	× 0	× 0	33	73	0	100
1.10 – 1.15	87	50	×33	× 0	0	43	56	100
1.15 – 1.20	× 57	73	×78	×67	14	13	22	33
1.20 – 1.24	×100	83	×94	×71	0	13	6	29
Above 1.24	×100	83	90	×71	0	10	10	28

Table 10. (Continued.)

Specific gravity	Class in diameter of wheat grains tested (mm)							
	Below 2.0	2.0 – 2.5	2.5 – 2.7	Above 2.7	Below 2.0	2.0 – 2.5	2.5 – 2.7	Above 2.7
	Germination percentage of wheat grains				Percentage of appearance of *G. Saubinetii* during the germination of grains			
Wheat variety: Hosogara.								
Below 1.00	33	3	0	× 0	63	93	93	96
1.00 – 1.05	67	7	0	× 0	33	73	100	100
1.05 – 1.10	76	23	× 7	× 0	10	53	93	100
1.10 – 1.15	90	67	×10	× 33	0	33	90	67
1.15 – 1.20	93	70	×41	×100	3	20	59	0
1.20 – 1.24	87	100	×62	× 50	3	0	38	0
Above 1.24	83	100	97	×100	0	3	0	0
Wheat variety: Sintyûnaga.								
Below 1.00	10	3	0	0	63	60	100	100
1.00 – 1.05	13	27	0	× 0	33	67	100	100
1.05 – 1.10	10	27	0	× 0	10	63	97	100
1.10 – 1.15	37	13	50	× 77	20	67	47	18
1.15 – 1.20	17	30	47	× 63	0	23	20	0
1.20 – 1.24	7	17	20	× 46	3	33	7	15
Above 1.24	× 0	7	7	× 14	0	17	0	29
Wheat variety: Hatakeda.								
Below 1.00	10	0	0	× 0	73	97	93	100
1.00 – 1.05	23	10	0	× 0	13	40	67	100
1.05 – 1.10	23	20	× 5	× 0	17	17	50	100
1.10 – 1.15	20	30	×22	× 0	10	23	31	100
1.15 – 1.20	17	23	40	× 0	7	20	27	100
1.20 – 1.24	10	17	40	× 50	7	17	17	25
Above 1.24	3	10	13	× 14	3	3	0	0

Remarks: The number of wheat grains tested were 30 grains. In some of the lots, however, 30 grains were not used for the shortage of the number. Such lots were marked with ×. The percentage of appearance of *Gibberella Saubinetii* is shown by the number of the seeds, from which *G. Saubinetii* appeared during the course of germination, when they were sown on sand in porcelain tray.

In all of the wheat varieties studied, the germination percentage of the grains became better with the increase of the specific gravity, and showed little relations to the size and the thickness of the grains. The rate of the occurrence of *Gibberella Saubinetii* during the course of the germination was very large, and the more the appearance of the mycelium, the less the germination percentage.

iii) *Relations among the Size, the Specific Gravity and the Presence of Internal Hyphae in Wheat Grains.*

The relations among the size, the specific gravity and the existence of the internal hyphae in wheat grains were studied in the previously stated manners. The results are given in Table 11.

Table 11.

Relations among the Size, the Specific Gravity and the Percentage of Existence of Internal Hyphae in Wheat Grains.

Wheat variety tested	Class in diameter of grains	Specific gravity of wheat grains			
		Below 1.00	1.05 – 1.10	1.15 – 1.20	Above 1.24
		Percentage of existence of internal hyphae			
Nôrin No. 4	Below 2.0 mm	100 %	60 %	10 %	10 %
	2.0 – 2.5 „	70	40	30	30
	2.5 – 2.7 „	100	60	20	10
	Above 2.7 „	70	100	40	22
Nôrin No. 6	Below 2.0 „	0	40	25	0
	2.0 – 2.5 „	70	90	40	10
	2.5 – 2.7 „	100	80	90	20
	Above 2.7 „	80	80	33	13
Hosogara	Below 2.0 „	20	30	0	20
	2.0 – 2.5 „	30	40	0	10
	2.5 – 2.7 „	80	44	0	0
	Above 2.7 „	60	0	0	33
Sintyûnaga	Below 2.0 „	30	10	10	20
	2.0 – 2.5 „	50	20	10	10
	2.5 – 2.7 „	60	40	20	10
	Above 2.7 „	70	30	30	30
Hatakeda	Below 2.0 „	50	0	30	0
	2.0 – 2.5 „	60	0	10	0
	2.5 – 2.7 „	60	30	20	10
	Above 2.7 „	89	0	0	0

Table 11 showed that the presence of the internal hyphae became smaller with the increase of the specific gravity, and concerned little with the size and the thickness of the grains.

IV. Summary.

1) The present paper deals with the specific gravity method as a control means for seedling blight, caused by *Gibberella Saubinetii* (MONT.) SACC.

2) Wheat grains of more than twelve varieties, harvested from blighted and healthy heads were graded into various classes, according to the specific gravity, the absolute weight and the diameter of the grains, respectively.

3) The germination and the presence of internal hyphae, in each of the above stated classes of wheat grains, were studied, and the percentage was determined.

4) The wheat grains heavier than 1.24 in specific gravity germinated very well and those of the majority of the varieties tested showed the germination percentage above 90 per cent, the average value being 91.6 per cent.

5) The wheat grains heavier than 1.24 in specific gravity showed no internal hyphae of *Gibberella Saubinetii*, with two exceptions of the varieties, Hatakeda and Pusa No. 12.

6) The germination percentage and the presence of the internal hyphae of *Gibberella Saubinetii* in wheat grains concerned little with the thickness and the absolute weight of the grains.

7) The wheat grains, developed on the blighted heads attacked by *Gibberella Saubinetii* in the fields, may be sown as the seeds for the next generation, if the heavy ones more than 1.20 or 1.24 in specific gravity are used.

8) Although the wheat grains with large specific gravity usually contained no internal hyphae of *Gibberella Saubinetii*, the surface disinfection must be undertaken to exclude the accidentally adhered fragments of the hyphae and the spores of *Gibberella Saubinetii*.

PLATE IX.

Wheat Grains of Two Varieties, Hatakeda and Nôrin No. 5 developed on Blighted Ears, attacked by *Gibberella Saubinetii* (Mont.) Sacc.

Four classes of the grains, graded by the specific gravity, are shown.